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(54) IMPROVEMENTS IN OR RELATING TO ORTHOTIC OR PROSTHETIC APPLIANCES

(71) I, SECRETARY OF STATE FOR SOCIAL SERVICES, do hereby declare the invention, for which I pray that a patent may be garnted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to orthotic or prosthetic appliances and more particularly but not exclusively to orthotic calipers.

Orthotic appliances such as described herein provide restraint and/or support for limbs and/or other articulated parts of the human or animal body. In particular, orthotic calipers offer restraint and support for the lower limbs.

Many of the calipers-designs known hitherto have been essentially of metallic construction in order to provide adequate strength and stiffness. Such calipers tend to be relatively heavy and cumbersome particulary for children. In such cases the calipers may be as much as 10 to 25% of the child's body weight.

Because of the differing physical shape of patients limbs it is customary to manufacture calipers as bespoke items according to well established designs. Typically the Orthotist measures the patient and communicates these measurements to a factory where the caliper is fabricated. Final fitting is then performed by the Orthotist in the clinic by further detailed bending of the side 'steels' to match the patient's requirements. Frequently the caliper needs to be returned to the factory for final finishing.

It is an object of the present invention to provide an orthotic or prosthetic appliance which is relatively light in weight whilst retaining adequate stifness and strength and which might be easily and accurately fitted in accordance with individual requirements of the patient.

The invention provides an orthotic or prosthetic appliance having at least one composite, load bearing strut each comprising at least one ductile member and at least one fibre reinforced plastics member, the members being juxtaposed or circumjacently disposed.

Preferably the ductile member is of aluminium or aluminium alloy, and the fibre reinforced plastics member is carbon fibre reinforced.

The composite, load bearing strut may be constructed in longitudinal sections having uniform end connection protions whereby the appliance may be assembled on a sectional basis from its component parts.

The invention also provides a method of producing a well fitted orthotic or prosthetic appliance by forming the fibre reinforced plastics member using an uncured thermosetting plastics material, by fitting the composite strut to a patient's limb by deforming the ductile member, and by finally curing the plastics material to make rigid the composite strut.

In order that the invention may be more fully understood, two embodiments thereof will now be described, by way of example only, with reference to the drawings accompanying the provisional specification, in which:

Figure 1 is a diagrammatic representation of an orthotic calliper designed in accordance with the invention.

Figure 2 is a cross-section on the line II—II of Fig. 1 and shows one design of structural member,

Figure 3 is a similar cross section showing an alternative design of structural member.

Referring to Fig. 1 the caliper includes a lower portion 1 having composite, load bearing struts 2 and 3 an an upper portion 4 having a composite, load bearing struts 5. Adjustable, limb encircling, padded strap members 7 and 8 are attached to the struts 2 and 3 and arranged to enable the lower portion 1 to be secured to the patient's legs. A spigot member 9 at the base of each of the struts 2 and 3 engages with a corresponding hole in the patient's shoes. The upper portion 4 includes adjustable padded strap members 10, 11 for attachment to the

patient's torso. Lockable hinge members 12 are provided between the struts 2 of the lower portion 1 and the struts 5 of the upper portion 4 to provide articulation of the portions of the caliper.

In use and as fitted and applied to the human body, the struts run approximately vertically along the patient's limbs and torso thereby supporting, and restraining the movement of the patient's limbs and enabling the patient to maintain an upright posture. Ideally, the strapping members 10 and 11 are designed respectively for attachment in the vicinity of and across the upper chest and buttocks of the patient and are usually reinforced for rigidity. They might be for example constructed in accordance with the general instruction given in Applicant's U.K. Patent No. 1,348,781 describing an orthotic harness.

The composite, load bearing struts are fabricated in aluminium alloy and carbon fibre reinforced plastics and have a cross section as illustrated in Fig. 2. The composite comprises an outer wall of tubular section 21 with an inner core 22 of carbon fibre reinforced plastics and may be formed by the following process. Lengths of aluminium tubing of substantially circular cross section are taken and densely packed with resin coated carbon fibres. This is formed by firstly dipping a large number of long carbon fibre tows (such as described in UK Patent No. 1,110,791) in a thermosetting resin and secondly drawing these tows into the tubing. The filled tubes are heated to a temperature below the resin curing temperature in order to reduce the viscosity of the resin whereupon the tube is passed through rollers for final shaping at this elevated temperature and the excess resin is squeezed out.

The lockable hinge members 12 are preferably of the self locking type and are adapted to receive the end portions of the struts 2, 3 and 5 in specially provided sockets. It is desirable that the struts are fixed into the sockets in the hinged members by adhesive means. The hinge members 12 are positioned on the caliper in the vicinity of the hip joint of the patient to provide suitable articulation of the upper and lower portions.

In an alternative embodiment the struts 2 3 and 5 are fabricated in a different manner and have a cross section as illustrated in Fig. 3. The struts of this embodiment comprise lengths of aluminium alloy extruded 'I' section 23, in the channels of which there is positioned carbon fibre reinforced plastics 24. The whole is encased in heat shrinkable thermo-plastic sheath 25. The composite struts so formed are then heated to allow the thermo-plastic sheath 25 to contract and compress the contained fibres against the extruded I-section 23. Care must be taken that this heating is controlled such that the plastics resin emerges in an un-cured condition and allows modification of the struts as desired during subsequent fitting.

Calipers according to the invention may be constructed substantially in accordance with known manufacturing techniques or alternatively may be produced in sectional form. With section construction the struts are fabricated with male end connection portions for insertion into corresponding female receiving portions in for example the hinge joint member. Attachment of the end connection portions might vary according to the individual design or preference.

As the composite, load bearing struts are fabricated with the thermosetting resin in the un-cured condition they are flexible and can be shaped to the configuration required to give an accurate fit on the patient's limbs. The caliper may now be assembled and fitted to the patient to check the accuracy of the preliminary fit. Following final fitting the calipers are simply heat treated by known techniques to cure the resin, thereby producing a strong stiff well fitted caliper. Completion of the fabrication process is achieved by adding any straps and padding which may be required.

The invention might also be applied to other forms of orthotic appliances, as also to prosthetic appliances particularly where lightness, fitting time, and accuracy are important criteria. For example, such requirements arise during the treatment of geriatric amputees.

In such cases a patient's longevity may be seriously limited if a means of ambulation is not provided soon after surgery. Such means may be provided by a temporary limb (or pylon).

Additionally in the case of extension prosthetics a natural leg which is deformed or shortened may require an artificial extension.

A prosthetic appliance in accordance with the invention can be constructed readily for use in either of the above applications. A suitable socket accomodates the limb stump or natural foot and this is joined by means of a composite strut as previously described to a "foot" or platform for contact with the ground. The limb extension so provided is light in weight and may readily be formed to accommodate the contours of the natural limb or limb stump. Hinges may incorporated between struts constructed in a sectional manner if required.

The particular embodiments hereinbefore illustrated and described are of a particular type designed for human patients, but it is not intended to restrict the invention to appliances for human use.

WHAT I CLAIM IS:—

1. An orthotic or prosthetic appliance having at least one composite, load bearing strut each comprising at least one ductile member and at least one fibre reinforced plastics member, the members being juxtaposed or circumjacently disposed.

2. An orthotic or prosthetic appliance as claimed in claim 1 in which the fibre reinforced plastics is carbon fibre reinforced.

3. An orthotic or prosthetic appliance as claimed in claim 1 or claim 2 in which the load bearing strut comprises a central ductile I-section member containing fibre reinforced plastics members within its open side channels.

4. An orthotic or prosthetic appliance as claimed in claim 1 or claim 2 in which the load bearing strut comprises an outer ductile tube member containing an inner core of fibre reinforced plastics.

5. An orthotic or prosthetic appliance as claimed any one of the preceding claims in which the ductile member is of aluminium or aluminium alloy.

6. An orthotic or prosthetic appliance as claimed in any one of the preceding claims in which the load bearing strut is constructed in longitudinal sections having uniform end connection portions whereby the appliance may be assembled on a sectional basis from its component parts.

7. An orthotic or prosthetic device as claimed in any one of the preceding claims in which the load bearing strut is encased by a heat shrunk thermo-plastic sheath.

8. A method of producing a well fitted orthotic or prosthetic appliance according to claim 1 by forming the fibre reinforced plastics member using an uncured thermosetting plastics material, fitting the composite strut to a patient's limb by deforming the ductile member, and finally, curing the plastics material to make rigid the composite strut.

9. A method of producing a well fitted orthotic or prosthetic appliance as claimed in claim 8 in which the composite, load bearing strut is substantially oval in cross section and is fabricated from a central ductile I-section member with a carbon fibre reinforced plastics composite maintained within the open side channels of the I-section member.

10. A method of producing a well fitting orthotic or prosthetic appliance as claimed in claim 9 in which the composite load bearing strut is covered by a heat shrinkable thermoplastic sheath.

11. An orthotic or prosthetic appliance substantially as hereinbefore described with reference to the drawings accompanying the provisional specification.

12. A method of producing a well fitted orthotic or prosthetic appliance substantially as hereinbefore described with reference to the drawings accompanying the provisional specification.

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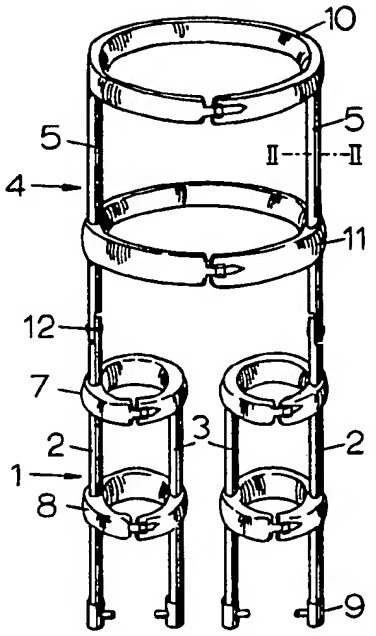

FIG. 1.

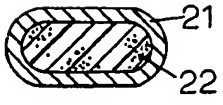

FIG. 2.

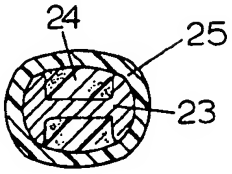

FIG. 3.